Epidemiology of Diabetes Mellitus in Mexico

Omar Y Bello-Chavolla[2,3], Rosalba Rojas-Martinez [1], Carlos A Aguilar-Salinas [2], Mauricio Hernández-Avila [1]

[1]Instituto Nacional de Salud Pública, Cuernavaca, Morelos, México

[2] Department of Endocrinology and Metabolism, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Mexico City, México

[3]MD/PhD (PECEM) Facultad de Medicina, Universidad Nacional Autónoma de México

CORRESPONDING AUTHOR:

Carlos A Aguilar-Salinas. Instituto Nacional de Ciencias Médicas y Nutrición, Departamento de Endocrinología y Metabolismo, Vasco de Quiroga 15, Col. Sector XVI, Tlalpan, Mexico City 14000, Mexico. Tel.: + 52 55 56554523; fax: + 52 55 55130002.

caguilarsalinas@yahoo.com

ABSTRACT

Type 2 Diabetes (T2D) is the main health problem in Mexico. The large and growing number of cases and the remarkable economic impact of the disease support this statement. The entity is expressed at an earlier age and at lower body mass index in Mexican mestizos compared to that reported in Caucasians. In addition, they have an increased susceptibility to having diabetic nephropathy. The Mexican health system needs major adjustments to prevent and treat T2D. Treatment is not currently based on the needs and expectations of the patient. As a result, it is insufficient, belated and costly. Close to 20% of the preventable deaths are caused by diabetes and related metabolic diseases. Even a small decrement of this rate may cause substantial savings to our health system.

KEY WORDS

Mexican population, prevention and control, diabetes mellitus, epidemiology, health care system.

For Review Only

INTRODUCTION

Close to 80% of the 415 million type 2 diabetes mellitus (T2DM) cases worlwide live in middle and low-income countries. A significant proportion of them (41.1 millions) reside in Latin America[1]. The age-adjusted prevalence for the region is 9.2% for adults (aged 20 to 79 years). Two of the ten leading countries for the number of cases are located in the Americas (Brazil (14.3 million) and Mexico (11.5 million). T2D is a prominent public health problem in Mexico. An alarming rapidly growing trend has been observed in this country during the past few decades. Not only does it increase cardiovascular risk, but it also confers an increased risk for diabetic retinopathy, limb amputations and kidney failure. Population growth and ageing and major changes in lifestyle have all contributed to an increased prevalence of T2D. Medical care for T2D and its complications entails an elevated cost for the national health system as well as significant expenses for patients and their families[2].

As with the majority of chronic non transmissible diseases, T2D occurs as a result of both environmental and genetic factors; lifestyle plays a decisive role in determining whether genetic predisposition will lead to disease. Within the last 30 years, Mexican population has concentrated in urban centers, which has contributed to a change in dietary patterns, with a significant increase in the consumption of total calories, processed food, simple carbohydrates, soft drinks and some sources of saturated fat. Using the 2006 national health survey, Barquera and coworkers estimated that the average diet composition was 61% carbohydrates, 12% protein and 26% fat (7.5% saturated fat). Nearly 36% of the adults have an excessive carbohydrates intake; the corresponding percentage for fat was close to 13%. A large proportion of the population has a lower than expected intake of vegetables, vitamin A and folic acid. The mean fiber intake was 20.7g/day. In addition the urban environment favors the use of cars and limits physical activity. The result of these changes is the chronic exposure of the population to a positive caloric balance and a rapid rise in the prevalence of obesity[3], a major determinant of the incidence of T2D. The obesity prevalence move from 20.9% to 32.4% between 1994 and 2012 for adults; in contrast, the prevalence of overweight (defined as a body mass index between 25-29.9 kg/m^2) remained unaltered (close to 38%).

For Review Only

The impact of T2D in mortality has had a progressive increase in Mexico. In 1970, T2D was the fifteenth cause of death. However, it move to the ninth and fourth main cause of general mortality in Mexico by 1980 and 1990, respectively.[4] Ever since 1998, T2D is amongst the leading causes of death in Mexico.[5] Starting from the year 2000, T2D has been the first cause of general mortality in Mexico, being responsible for 10.7% of the deaths registered that year.[6] As shown in **Table 1**, the T2D mortality rate has increased, reaching 14.5% in 2010. Since the year 2000, T2D is the most common cause of death in women and the second in men after coronary heart disease, a condition that can frequently be the result of T2D.[6] Mortality rates have had a larger increase for men (42.2 to 51.6 per 1000,000 population, 22.2% increase) than women (51.2 to 61.8 per 100,000 inhabitants, 17.1% increase); the average age at death is 66.7 years. Diabetes related mortality is higher in central and northern Mexico. Mexico City is nearly 30 points above the national average, followed by the State of Coahuila. The Mexican states with the lower mortality rates attributable to T2D are Quintana Roo (37.14 per 100,000), Chiapas (46.68 per 100,000) and Baja California Sur (50.76 per 100,000).[7] As opposed to what has happened in other countries, the mortality rates for T2D, coronary heart disease and stroke have maintained a steady rise between 2000 and 2013[8].

PREVALENCE

Mexico is among the few countries of the region that has four population based surveys in the past three decades. Prevalence data from National Health Surveys 1993[9], 2000[10] and 2006[11] are derived from the number of previously diagnosed (PD) subjects and cases found during the surveys (FP). The most recent data were obtained in 2012, but the prevalence of the previously undiagnosed cases has not been informed[12]. The prevalence has grown from 6.7% in 1993 (PMD 4.6% and FP 2.1%) to 7.5% in 2000 (PMD 5.8% and FP 1.7%) [10] and to 14.4% in 2006 (PMD 7.3% and 7.1% FP).[11] The increases were similar for both sexes and for rural and urban areas. Results from ENSANUT 2012 show that the T2D prevalence based on PMD is 9.2% among adults over age 20. Thus, 6.4 million Mexican adults have the diagnosis of T2D[13]. The highest prevalence was found in adults aged 60-69 years (26.3%); men had the highest

For Review Only

prevalence between the ages of 50-59 and women between the ages of 60-69 (**Figure 1)**.

Early onset T2D (defined as age of onset before 40 years) has increased in recent years from 1.8% in 1993 (PMD 1.0%, FP 0.8%) [14] to 2.3% in 2000 (PMD1.5%, FP 0.8%) [15] and to 5.7% in 2006 (PMD 1.5%, FP 4.21%).[16] The prevalence of undiagnosed T2D is almost three times greater than the previously diagnosed cases, which might indicate a lower attendance to medical services by younger people and the lack of awareness of the disease.

T2D screening and diagnoses is below the international standards.[11] The proportion of the population with undiagnosed T2D found by the survey in 2006 was practically the same as the proportion of cases with previous medical diagnosis: 7.1% and 7.3% respectively. This proportion contrasts with the low rates (5-10%) informed for European countries

The prevalence of T2D is higher in urban areas of the center-west region of Mexico, amongst population with six or less years of education, medium or high socioeconomic levels and amongst people enrolled at the Institute for Security and Social Services for State Workers (ISSSTE, in Spanish) (**Table 2)**. The prevalence of T2D in Mexico is significantly higher in population with family history of T2D, obesity and the presence of concurrent chronic diseases such as hypertension, hypercholesterolemia, kidney disease and microalbuminuria.[10]

SCREENING

The Mexican adult population who went through T2D screening in the previous year increased from 10.5% in 2000 to 22.7% in 2006. Of these, 12% in 2000 and 6.2% in 2006 did not receive their results.[17] A fifth part of the adults who attended a preventive medical service for T2D screening during the year previous to ENSANUT 2006 presented symptoms related to the disease. This proportion was higher amongst people between 40 and 59 years and those 70 years or older.

CLINICAL EXPRESSION OF T2D AND ITS CO-MORBIDITIES IN MEXICO

For Review Only

Based on ENSA 2000 and ENSANUT 2006, the most common characteristics of patients with T2D are an average age of 55.8 years in males, 56.4 years in females, overweight (27.9 Kg/m^2 for males and 28.9 Kg/m^2 in females), waist circumference of 99.3cm in males and 99.3cm in females and with a time period since the diagnosis of 9.3 years in males and 8.4 years in females. The average age at diagnosis was 48 years, being lower in women. A high percentage of the population with T2D in the study had at least one cardiovascular risk factor (86.7%) (hypercholesterolemia, arterial hypertension and smoking); if only modifiable risk factors are considered the percentage is 65%. Nearly half the patients had hypertension (35.5% in males and 46.6% in females). A third of the patients with hypertension were diagnosed during the study; the most common blood pressure abnormality was the coexistence of both systolic and diastolic hypertension (50.3%). Amongst previously diagnosed patients with hypertension, only 80% had received hypertensive treatment and only 30.6% of those patients had blood pressure levels below 140/90mmHg. Smoking was registered in 14.5% of patients and 28.7% pf patients reported having family history of coronary artery disease. Dyslipidemia is one of the most common comorbidities in T2D, with higher triglycerides and non-HDL cholesterol levels than the general population. LDL cholesterol (LDL-C) levels >100mg/dL were observed in 74.8% (95% CI 72.5-76.9%) of T2D patients with PMD; however, only 7.6% (95%CI 6.3-9.1%) of those cases knew they had hypercholesterolemia.

A high percentage of women with T2D had at least one pregnancy during their lifetimes (n=2373, 94.7%); this proportion was similar to the one found in patients without T2D. However, the number of women who had suffered at least one abortion was higher in the group with diabetes (OR 1.62, 95% CI 1.53-1.83) and a similar trend was found for the risk of stillbirth (OR 1.99, 95% CI 1.75-2.3); these differences were held significant when adjusted by age. Fertility control is part of T2D management. Unplanned pregnancies should be avoided to reduce obstetric morbidities. A high percentage of women with T2D during their reproductive years did not use contraceptive methods (42.5%); this rate was not significantly different in women without T2D (38.8%). The lack of differences in the use of contraceptive methods among women with childbearing

For Review Only

potential with or without T2D is a concern. This observation is a window of opportunity to enable public policies to reduce diabetes-related obstetric complications.

T2D EXPRESSION IN DIFFERENT AGE GROUPS

Age is one of the most important determinants of T2D prevalence; it varies from 3.2% in the population between 20-29 years to 32.75% in people between 60-69 years decreasing to 26.21% in the population over 70 years. The age of onset determines clinical characteristics and the burden of disease; early onset increases the social and economic burden because of chronic complications and premature disability during productive years. In 2006, prevalence of early onset T2D was 5.8%; most of them ignored their condition. However, due to the age distribution of the population, 22.7% of people with T2D are under the age of 40.

A sub study of 1994 Survey reported a T2D prevalence in the population under 40 years of 1.8%,[18] representing 14.8% of all T2D cases. Later the 2000 Survey reported a T2D prevalence of 2.3% for the 20-40 years age group; early presentation of T2D occurred in 13.2% of the T2D population. ENSANUT 2006 showed a substantial increase in the prevalence of disease both in the general population and amongst the 20-40 years age group (14.4% in the general population and 5.8% in the 20-40 years age group), a nearly two-fold increase in the prevalence of T2D from the year 1994. The growing trend in the prevalence is stronger for the early onset T2D; the number of patients increased from 318,400 in 1994 to 1,662,870 in 2006.

Early onset T2D comprises a heterogeneous population. Two thirds of them have a BMI >25kg/m^2; amongst them, hypertension and hypoalphalipoproteinemia are common co-morbidities (32.5% for arterial hypertension and 79.3% for hypoalphalipoproteinemia). They are usually treated with oral glucose lowering agents. In contrast, insulin is more often used as a part of T2D treatment amongst non-overweight patients. Within this subgroup, a study identified cases of MODY (with mutations in *HNF1α* or *HNF14α*) or positive anti-GAD antibodies (6% of cases). [19]

When compared to the overall population with T2D, the young T2D population had a higher prevalence of underdiagnosis (70%), more school years, but a lower socioeconomic level. In terms of cardiovascular risk factors, young populations had a

For Review Only

higher alcohol and tobacco consumption, an average BMI of 27 kg/m^2 and a lower prevalence of hypercholesterolemia. In contrast, hypoalphalipoproteinemia (HDL cholesterol <40mg/dL) was more common among them. Diabetic retinopathy was present in 7.6% of patients under the age of 40 and 6.3% referred having suffered a previous myocardial infarction. Despite these complications and outcomes, few young patients undertake preventive measures, with very few receiving statins or acetyl-salicylic acid (ASA) or follow up with an ophthalmologist.

The elderly patient with T2D conforms also a heterogeneous population with two extremes.[20-21]. The first is composed of T2D patients with a longer exposure to the disease and thus, prone to chronic complications, increasing third-party dependence and requiring a more complex management. The second group is composed of patients diagnosed with T2D after the age of 70; these patients have a low prevalence of microvascular complications and their glucose levels can be kept stable with one or two oral hypoglycemic agents. Both groups are represented in similar proportions. Among T2D elders, the mean age at diagnosis is 57±10 years and the time of exposure to the disease is 11±8 years. Almost half of them had 10 years or more from the time of diagnosis, the mean BMI was 28.4±5 kg/m^2; 82.2% were treated with only one hypoglycemic agent and 7.6% received insulin treatment. Cardiovascular risk factors were common in this age group, 37.6% had smoked at least one cigarette within the previous month before the survey, 60% had hypertension and 88.7% was taking one or more antihypertensive agents, microalbuminuria was detected in 48.4% of cases. Geriatric problems were also common, 8.8% of patients within this age group had suffered a fall in the last year, motor limitations were referred by 30% of patients and 17.8% reported regular use of sedative agents.

TREATMENT AND CONTROL

Correction and control of hyperglycemia is the basis for the prevention of microvascular complications (kidney disease, neuropathy and retinopathy). A large percentage (93.3%) of T2D patients in ENSANUT 2012 reported receiving pharmacologic treatment; 84.8% were receiving oral hypoglycemia agents, 6.8% insulin and 2.5% a combination of both[22]. Mean HbA1c levels, a marker of glycemia within the previous 6-8

For Review Only

weeks, was 9.3% (2.2% below the value reported in 2006). Only 25% of T2D patients had HbA1c <7%; severe hyperglycemia (HbA1c >9%) was found in 50.3% of cases. These percentages are non-satisfactory when compared with data from the Diabetes in Canada Evaluation (DICE), where 51% of patients have HbA1c <7.0% and in the USA, the National Health and Nutrition Examination Surveys, indicate that 57% of patients had HbA1c concentrations <7.0%.

The unsatisfactory effectiveness of glycemic control cannot be attributed only to lack of access to medical care; 94.1% had at least one medical evaluation in the previous year. Only 24.17% and 1.86% of patients considered diet and physical activity as part of their treatment, respectively. Alternative medicine was the treatment option for 6.1% of T2D population. Only 21.7% of patients reported in ENSANUT 2012 had glycemic levels determined 4 or more times every year and 7.7% of patients had at least 2 HbA1c determinations every year. Factors associated with an unsatisfactory glycemic control included age, low BMI, longer duration of T2D and insulin use.

Table 3 describes the accomplishment of treatment goals in T2D patients in Mexico[22]. Only 80% of cases with T2D and hypertension received antihypertensive medication and 76.6% of cases had blood pressure levels higher than the therapeutic goals. Nearly half the patients with both T2D and hypertension had no knowledge of having high blood pressure. Only 5% of previously diagnosed and treated patients reached therapeutic goals and nearly a fifth part of patients with hypertension did not receive treatment despite knowing their diagnosis. Additionally, less than 10% of T2D patients are treated with a statin, despite being indicated in more than half of the cases. Interventions that have proved a reduction of chronic complications, such as the regular administration of low-dose ASA are not well implemented (only in 10% of cases). As a result, the proportion of patients who fulfill the attention quality indicators for T2D is low. Gakidou et al. compared the data in Mexico against results obtained by surveys conducted in the United States, Asia and Europe. Mexico had a poor performance in the attention of hyperglycemia and the comorbidities associated with T2D; less than 5% of cases reached therapeutic goals as measured by HbA1c concentrations, blood pressure and LDL-c levels. Only 20% of cases received adequate treatment without reaching treatment goals; one or more of the therapeutic goals had not been diagnosed

For Review Only

or treated in the rest of the cases. The country with the better performance was the United States with 10% of cases with optimal treatment, 50% with insufficient treatment and 40% in which at least one diagnosis was omitted.

CHRONIC COMPLICATIONS

Screening for T2D chronic complications is area of opportunity to improve diabetes care in Mexico. Only 14.7% had an annual feet exam, 8.6% underwent retinopathy detection and 12.6% had an albuminuria measurement. Amongst this population, 14.6% referred having some degree of retinopathy, 13.4% had lost sensibility in at least one part of their bodies, 9.4% reported having had ulcers in legs or feet, 4.9% were blind, 3% had some amputation, 2.3% had been diagnosed with diabetic foot and 1.2% had received dialysis.

T2D is one of the main causes of premature disability, blindness, terminal chronic kidney disease and non-traumatic amputations as well as one of the ten most frequent cases of hospitalization in adults. In 2009, 2.8% of hospital discharges were due to the management of T2D complications. The institution with the heaviest diabetes-related burden is the Instituto Mexicano del Seguro Social; it provides medical care to 44.9% of the T2D population. The Health Ministry delivers care to 36.2% of the T2D patients; in its hospitals there were 51,807 discharges attributable to T2D in 2007[22] and 36% of them was due to chronic complications.[23] A study conducted in the State of Mexico,[24] which included 44,458 subjects diagnosed with T2D, registered the presence of diabetic retinopathy in 10.9%, diabetic nephropathy in 9.1%, peripheral neuropathy in 17.1%, ischemic cardiomyopathy in 4.2% and stroke in 1.7% of the studied population. In the Mexico City Study, the prevalence of proliferative diabetic retinopathy was 8% and 40% for non-proliferative diabetic retinopathy; the incidence of retinopathy after a 4 year follow-up period was 22.5%.[25]

FUTURE ESTIMATES FOR THE INCIDENCE OF T2D COMPLICATIONS

Based on T2D patients' data from ENSANUT 2006, Reynoso-Noverón et al. estimated that 112 cases per 1,000 persons with T2D will suffer at least one ischemic coronary event within the next 20 years.[26] In the same period, there will be 889,433 new cases of

For Review Only

heart failure; 2,048,996 events or myocardial infarction; 798,188 stroke events and 491,236 non-traumatic amputations attributable to T2D. The expected mortality rate is 539 per 1,000 persons with T2D with an average life expectancy of 10.9 years.

COST OF DIABETES

The direct and indirect costs of T2D treatment are remarkable. In 2010, researchers from the National Institute of Public Health in Mexico calculated that the greater direct costs correspond to medications ($133,143,734), followed by complication costs ($110,410,928), consult/diagnosis-related costs ($59,734.448) and hospitalization costs ($39,937,331). Indirect costs are mainly due to permanent disability ($409,205,846), followed by costs due to premature mortality ($19,623,029) and costs due to temporal disability ($6,372,059). Both the direct and indirect cost are paid mainly by patients and social security institutions.[27]

During 2012, 168,406 hospital discharges were associated with diabetes complications, accumulating over 685,208 days of hospital stay with an average cost per bed day between $2,150- 5,500 Mexican pesos, causing a cost burden of $1, 473 million to $3,768 million pesos. This figure does not include costs for emergency care.

AREAS LACKING SUFFICIENT INFORMATION

Despite the information obtained by National Health Surveys, there are still aspects of T2D epidemiology that have not been fully explored; two examples of these information gaps are the prevalence of T2D in special groups and the incidence of diabetes. The first aspect is attributed to the lack of representative studies that explore diabetes prevalence in children, adolescents, pregnant women, type1 diabetes, indigenous groups and groups with higher risk for secondary diabetes. Studies within pediatric population are usually limited to cohort studies of cases in reference hospitals; such studies report that the percentage of T2D cases has increased two-fold in recent years. There is only one study with enough population representability.[28] This situation is similar for gestational DM; a recent study informed a prevalence of 10.3% with the American Diabetes Association criteria and 30.1% when using the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria in 905 women

For Review Only

patients of the National Institute of Perinatology.[29] There are reports of the prevalence of T2D in DM in some indigenous Mexican groups (Mazatecas,[30] Otomíes,[31] Pimas,[32] Yaquis, Tepehuanas, Purépechas, Huicholes and Mexicaneros[33, 34]). However, these studies have a small sample size and do not represent this specific population. Despite this limitations, there is a trend that shows an increased prevalence in most recent reports, similar to what has been observed in rural populations. Studies focused on indigenous groups that live in urban areas are required since they have gone through rapid lifestyle modifications and a greater incidence of T2D [35, 36]. Additionally, there are no national records or interinstitutional databases that allow evaluation of the Mexico's national health system's effectiveness in T2D treatment.

CONCLUSION: CHALLENGES AND OPPORTUNITIES

T2D and other chronic diseases must be confronted with complementary actions. This approach has been the proposal of national prevention plans[37, 38] and it follows the recommendations of the World Health Organization[39] and the Pan American Health Organization.[40] The goals are the prevention of new cases, decreasing the incidence of complications and reducing mortality and disability.

The natural history of T2D can be modified. In particular, actions that halt the growing trend of obesity in Mexicans may have a remarkable impact in T2D incidence. In addition, it may decrease the proportion of T2D cases that has comorbidities associated with a higher morbidity and mortality (i.e. lipid disorders or arterial hypertension). Campaigns to stimulate the adoption of a healthy lifestyle should be permanently in place; messages should be adapted to the needs of the various subsets of the population. For the assessment of such interventions, the development of prognostic tools and the creation of pharmacoeconomic models should be built in the next few years.

The national health system needs major adjustments to confront the challenges caused by T2D. Primary care units should be organized to make diagnoses on time and provide low cost structured prevention programs. In addition, a renewed focus on effectiveness of the interventions should reinforced. The lack of effectiveness is explained by factors attributable to the health system, physicians and patients. Diabetes management is

For Review Only

based on principles that differ from that of communicable diseases; it implies a complex educational process to understand the disease, behavioral changes, the long-term use of multiple drugs, frequent evaluations as well as a conjoined effort between the patient, specialists, family and the community[41] .The structure and procedures currently implemented by most health institutions in Mexico are not prepared for such treatment approach. The time of the medical consultations should be long enough to implement a treatment plan and for the detection of chronic complications. The prominent role of the highly specialized physicians should be replaced with a greater participation of a wide range of health professionals (i.e. nutritionists, physical education specialists, psychologists, educators, physical therapists, among others). The involvement of the family to promote lifestyle changes and elements that are critical for treatment adherence must be taken into consideration in a systematic manner.[42, 43] Empowerment of the individuals to make wise decisions regarding their life style and their T2D treatment is feasible. Treatment should be adapted to the patient's needs and expectations[44]. Surveillance programs (using internationally accepted indicators) may have a significant impact in less than a decade to decrease the cost and burden impose by T2D to our health system. Specifically, close to 20% of the preventable deaths in Mexico are caused by T2D. Even a small decrement of this rate may cause substantial savings to our health system.

For Review Only

ACKNOWLEDGMENTS

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

REFERENCES

1. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27:1047-53.
2. Arredondo A, De Icaza E. The cost of diabetes in Latin America: evidence from Mexico. Value Health. 2011;14(5 Suppl 1):S85-8

3. Barquera S, Hernàndez-Barrera L, Campos-Nonato I, Espinosa J, Flores M, Barriguete A, Rivera JA. Energy and nutrient consumption in adults: Analysis of the Mexican National Health and Nutrition Survey 2006. Salud Publica Mex 2009;51 suppl 4:S562-S573.
4. Secretaría de Salud (SSA) Compendio Histórico. Estadísticas Vitales 1893 – 1993.
5. Lozano R, Torres LM, Lara J, Santillán A, Solíz P. Efecto de la CIE-10 en las estadísticas de diabetes mellitus en México. Síntesis ejecutiva No 7. Publicaciones. Secretaría de Salud, México.
6. Secretaria de Salud. Estadísticas de Mortalidad en México: muertes registradas en el año 2000. Salud Pública de México 2002;44:266-282.
7. Sánchez-Barriga JJ. Mortality trends from diabetes mellitus in the seven socioeconomic regions of Mexico,2000–2007. Rev Panam Salud Publica 2010;28:368–75.
8. Burke JP, Williams K, Haffner SM, Villalpando CG, Stern MP. Elevated incidence of type 2 diabetes in San Antonio, Texas, compared with that of Mexico City, Mexico. Diabetes Care. 2001;24:1573-8
9. SSA. Encuesta Nacional de Enfermedades Crónicas 1993. México, D.F.: Secretaría de Salud, 1994.
10. Olaiz-Fernández, G, Rojas R, Aguilar-Salinas C, Rauda J, Villalpando S. Diabetes mellitus in Mexican adults: results from the 2000 National Health Survey. Salud Pública Mex 2007;49:331-337.
11. Villalpando S, Rojas R, Shamah-Levy T, Ávila MA, Gaona B, De la Cruz V, et al. Prevalence and distribution of type 2 diabetes mellitus in Mexican adult population. A probabilistic survey. Salud Pública Mex 2010; 52 suppl 1:S19-S26.
12. Villalpando S, Shamah-Levy T, Rojas R, Aguilar-Salinas CA. Trends for type 2 diabetes and other cardiovascular risk factors in Mexico from 1993-2006. Salud Pública Mex 2010;52 suppl 1:S72-S79.
13. Gutierrez JP, Dommarco J, Shamah T, Villalpando S, Franco A, Cuevas L, Romero M, Hernández M. Encuesta Nacional de Salud y Nutrición 2012.

For Review Only

Resultados Nacionales. Cuernavaca México, Instituto Nacional de Salud Pública, 2012

14. Aguilar-Salinas CA, Rojas R, Gómez-Pérez FJ, García E, Valles V, Ríos-Torres JM, et al. Early onset type 2 diabetes in a Mexican, population-based, nation-wide survey. Am J Medicine 2002;113:569-574
15. Aguilar-Salinas CA, Velazquez-Monroy O, Gómez-Pérez FJ, Gonzalez-Chávez A, Lara-Esqueda A, Molina-Cuevas V, et al. for the ENSA 2000 Group. Characteristics of the patients with type 2 diabetes in México: results from a large population-based, nation-wide survey. Diabetes Care 2003:26:2021-2026.
16. Jiménez-Corona A, Rojas R, Gómez Pérez FJ, Aguilar-Salinas CA. Early-onset type 2 diabetes in a Mexican survey: Results from the National Health and Nutrition Survey 2006. Salud Pública Mex 2010;52 suppl 1:S27-S35.
17. Rojas R, Palma O, Quintana I. Adultos. En: Olaiz G, Rivera J, Shamah T, Rojas R, Villalpando S, Hernández M, Sepúlveda J (editores). Encuesta Nacional de Salud y Nutrición 2006. Instituto Nacional de Salud Pública
18. Villalpando S, Shamah-Levy T, Rojas R, Aguilar-Salinas CA. Trends for type 2 diabetes and other cardiovascular risk factors in Mexico from 1993-2006. Salud Pública Méx 2010: 52 (supl1). S72-S79
19. Jimenez Corona A, Rojas Martinez R, Gómez-Pérez FJ, Aguilar-Salinas CA. Early onset type 2 diabetes in a Mexican, population-based, nation-wide survey: Results of the Encuesta Nacional de Salud y Nutrición 2006. Salud Pública Méx 2010: 52 (supl1). S27-S35
20. Aguilar-Salinas CA, Reyes-Rodríguez E, Ordóñez-Sánchez ML, et al. Early-Onset Type 2 Diabetes: Metabolic and Genetic Characterization in Mexican Population. J Clin Endoc Metab 2001;86:220-226.
21. Mehta R, Del Moral ME, Aguilar Salinas CA. Epidemiologia de la diabetes en el anciano. Rev Invest Clin 2010;62:305-311.
22. Flores-Hernández S, Saturno-Hernández, PJ, Reyes-Morales H, Barrientos-Gutiérrez T, Villalpando S, Hernández-Ávila M. Quality of diabetes care: The challenges of an increasing epidemic in Mexico. Results from two national health surveys (2006 and 2012). PLoS ONE 2015;10(7): e0133958.

For Review Only

23. Estadística de egresos hospitalarios del Sector Público del Sistema Nacional de salud. Dirección General de Información y Evaluación del Desempeño. Salud Publica Mex 2002; 44: 158-187
24. Rodríguez-Moctezuma JR, López-Carmona JM, Rodríguez-Pérez JA, Jiménez-Méndez JA. Características epidemiológicas de pacientes con diabetes en el Estado de México. Rev Med Inst Mex Seguro Soc 2003; 41: 383-392.
25. González-Villalpando C, González-Villalpando ME, Rivera Martínez D, Stern MP. Incidence and progression of diabetic retinopathy in low income population of Mexico City. Rev Invest Clin 1999; 51: 141-150.
26. Reynoso-Noverón N, Mehta R, Almeda-Valdes P, et al. Estimated incidence of cardiovascular complications related to type 2 diabetes in Mexico using the UKPDS outcome model and a population-based survey. Cardiovascular Diabetology. 2011;10(1):1
27. Arredondo A, de Icaza E Financial requirements for the treatment of diabetes in Latin America: implications for the health system and for patients in Mexico. Diabetologia. 2009;52:1693-5.
28. Aude Rueda O, Libman IM, Altamirano Bustamante N, Robles Valdes C, LaPorte RE.Low incidence of IDDM in children of Veracruz-Boca del Rio, Veracruz. Results of the first validated IDDM registry in Mexico. Diabetes Care. 1998;21:1372-3.
29. Reyes-Muñoz E, Parra A, Castillo-Mora A, Ortega-González C. Impact of the International Association of Diabetes and Pregnancy Study Groups diagnostic criteria on the prevalence of gestational diabetes mellitus in urban Mexican women: A cross-sectional study. Endocr Pract. 2011; 17: 1-17.
30. Castro-Sánchez H, Escobedo-de la Peña J. Prevalence of non insulin dependent diabetes mellitus and associated risk factors in the Mazatec population of the State of Oaxaca, Mexico. Gac Med Mex 1997; 133: 527-534.
31. Alvarado-Ozuna C, Milian-Suazo F, Valles-Sánchez V. Prevalencia de diabetes mellitus e hiperlipidemias en indígenas otomíes. Salud Publica Mex 2001; 43: 459-463.

For Review Only

32. Schulz LO, Bennett PH, Ravussin E, et al. Effects of traditional and western environments on prevalence of type 2 diabetes in Pima Indians in Mexico and the U.S. Diabetes Care 2006; 29: 1866-1871.
33. Guerrero-Romero F, Rodríguez-Morán M, Sandoval-Herrera F. Low prevalence of non-insulin-dependent diabetes mellitus in indigenous communities of Durango, Mexico. Arch Med Res 1997; 28: 137-140.
34. Guerrero-Romero F, Rodríguez-Moran M, Sandoval-Herrera F. Prevalence of NIDDM in indigenous communities of Durango, Mexico. Diabetes Care 1996; 19: 547-548.
35. Rodríguez Carranza S, Aguilar Salinas CA Anormalidades metabólicas en pacientes con infección por VIH. Revista de Investigación Clinica 2004: 56: 193-208
36. Aguilar-Salinas CA, Díaz-Polanco A, Quintana E, et al. Genetic factors play an important role in the pathogenesis of hyperlipidemia post-transplantation. Am J Kidney Dis 2002;40:169-177.
37. Finnish Diabetes Association. Implementation of the type 2 diabetes prevention plan in Finland. Finnish Diabetes Association 2006.
38. Australian Centre for Diabetes Strategies. National evidence based guidelines for the management of type 2 diabetes mellitus: Primary prevention, case detection and diagnosis. Edited by National Health and Medical Research Council, 2001.
39. World Health Organization. Non communicable diseases prevention and control. World Health Organization. Genova, Suiza. 2006.
40. Pan American Health Organization. Regional strategy and plan of action on an integrated approach to the prevention and control of chronic diseases, including diet, physical activity and health. Pan American Health Organization, Washington DC, EUA. 2006
41. Etzwiler DD. Don't ignore the patients. Diabetes Care 2001;24:1840-1841.
42. Rivera-Gallardo T, Parra-Cabrera S, Barriguete-Meléndez JA. Trastornos de la conducta alimentaria como factor de riesgo para la osteoporosis. Rev. Salud Pública de México. 2005; 47:308-318.

For Review Only

43. Barriguete-Meléndez JA, Rivera MT, Pérez A, Emmelhainz M. La Conducta Alimentaria y el equilibrio Bio-Psico-Familiar. Revista Iberoamericana de Psicología. 2005: 13; 68-73

44. Salinas J.L. Pérez P, Viniegra L, Barriguete-Meléndez JA, Casillas J., Valencia A. Modelo Psicodinámico Sistémico de Evaluación Familiar. Rev Inv Clin 1992. 44;2:169-188.

FIGURES

FIGURE 1. Prevalence of diabetes mellitus according to age group, type of diagnosis and sex. ENSANUT 2006 (%).

FIGURE 2. Coverage of prevention programs for T2D screening. ENSANut 2006

FIGURE 3. Prevalence of T2D in population with 20 years and over according to family history of T2D in parents ENSA 2000.

FIGURE 4. Prevalence of T2D according to type of diagnosis and BMI. ENSANut 2006.

For Review Only

505 **TABLE 1**

506 **Mortality attributable to Diabetes Mellitus**

Year	Deaths	Mortality rate (per 100,000 population)	Percentage (%)
2000	46 525	46.26	10.7
2001	49 855	48.96	11.3
2002	54 828	53.21	12.0
2003	59 119	56.73	12.6
2004	62 201	59.0	13.2
2005	67 090	64.5	13.6
2006	68 353	65.2	13.9
2007	70 451	66.6	13.7
2008	75 572	70.8	14.0
2009	77 699	72.2	14.2
2010	82 964	74.0	14.5

Source: Health Secretariat/Dirección General de Información en Salud. Elaborated from a database of deaths through 1979-2008 INEGI/SS and in Population Projections in Mexico 2005 – 2050 and retrospective projections 1990-2004. CONAPO 2006.

507

For Review Only

TABLE 2

Prevalence of T2D according to sociodemographic characteristic, type of diagnosis and sex. ENSANUT 2006 (%).

		Men			Women			Total		
		PMD	FP	Total	PMD	FP	Total	PMD	FP	Total
Locality size	Rural	5.2	4.3	9.5	5.8	5.3	11.1	5.5	4.8	10.3
	Urban	7.5	10.0	17.5	8.1	5.6	13.7	7.8	7.7	15.5
Region	North	6.1	6.9	13.0	6.3	6.2	12.5	6.2	6.5	12.7
	Center-West	9.8	9.9	19.7	10.5	6.4	16.9	10.2	8.1	18.3
	Center	6.6.	11.6	18.2	7.6	4.4	12.0	7.1	7.7	14.8
	South-Southwest	5.0	5.1	10.1	6.3	5.8	12.1	5.7	5.5	11.2
School years	≤ 6 years	9.7	8.5	18.2	11.9	7.0	18.9	11.0	7.6	18.6
	> 6 years	4.8	9.1	13.9	2.9	4.0	6.9	3.8	6.6	10.4
SEL	1-2 decils	6.1	4.6	10.7	7.3	5.6	12.9	6.8	5.1	11.9
	≥3	7.5	11.1	18.6	7.9	5.6	13.5	7.7	8.2	15.9
Enrollment	IMSS	9.5	12.1	21.6	7.3	5.4	12.7	8.3	8.5	16.8
	ISSSTE	17.3	7.6	24.9	7.7	7.7	15.4	11.8	7.7	19.5
	SPSS	5.5	7.0	12.5	9.0	4.1	13.1	7.5	5.3	12.8
	Private	0	0	0	25.3	6.0	31.3	10.4	2.5	12.9
	Other	4.7	9.3	14.0	9.7	4.5	14.2	8.0	6.1	14.1
	Neither	5.1	7.5	12.6	7.2	5.8	13.0	6.2	6.6	12.8

For Review Only

TABLE 3

Characteristics (%) of the patients with T2D in the 2012 National Health Survey

	Total
Age (years)	56.9 (56.6.-57.0)
Time since diagnoses (years)	9.2 (9.0-9.6)
With pharmacologic treatment (%)	85.6 (85.0-86.1)
HbA1c < 7% (%)	25.6 (20-31.2)
HbA1c > 9% (%)	50.3 (44.6-55.9)
Four or more visits to a medical unit per year (%)	65.4 (64.9-66)
Two or more HbA1c measurements per year (%)	7.7 (7.3-8.2)
Current statin use (%)	2.6 (1.6-3.6)
Annual foot exam	14.7 (14.1-15.2)
Annual eye exam	8.6 (8.1-9.0)

Results are presented as mean or percentages and 95% confidence intervals.

For Review Only

FIGURE 1

Prevalence of diabetes mellitus according to age group, type of diagnosis and sex. ENSANUT 2006 (%).

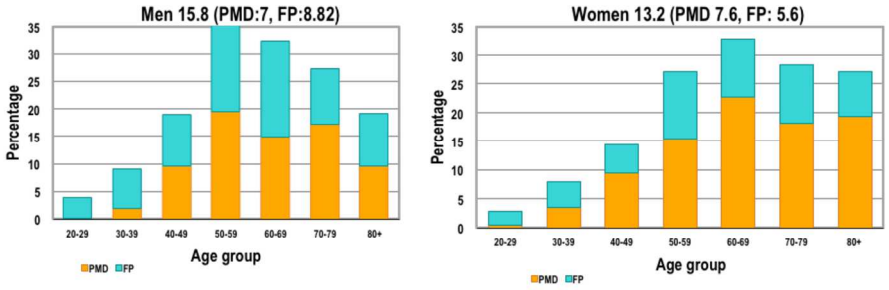


FIGURE 1
Prevalence of diabetes mellitus according to age group, type of diagnosis and sex. ENSANUT 2006 (%).
279x215mm (200 x 200 DPI)

Only

FIGURE 2

Coverage of prevention programs for T2D screening. ENSANut 2006

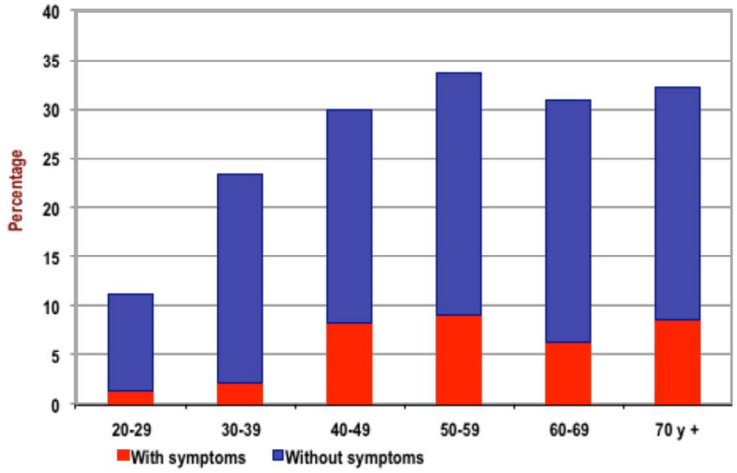


FIGURE 2
Coverage of prevention programs for T2D screening. ENSANut 2006
279x215mm (200 x 200 DPI)

Only

FIGURE 3

Prevalence of T2D in population with 20 years and over according to family history of T2D in parents ENSA 2000.

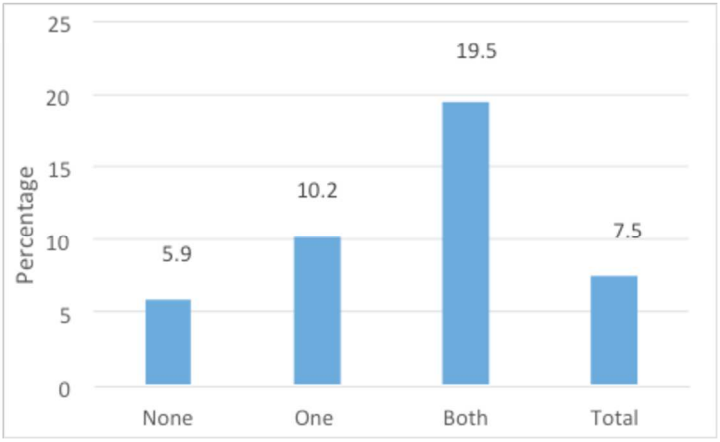
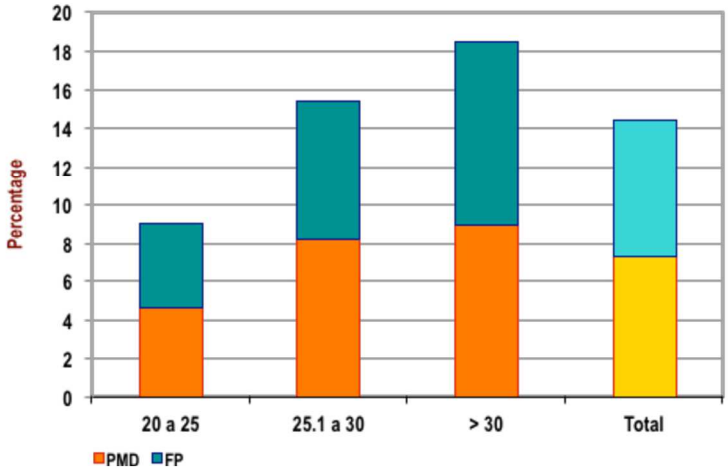


FIGURE 3
Prevalence of T2D in population with 20 years and over according to family history of T2D in parents ENSA 2000.
279x215mm (200 x 200 DPI)

Only

FIGURE 4

Prevalence of T2D according to type of diagnosis and BMI. ENSANut 2006.



PMD: Cases with previous diagnosis

FP: cases found during the surveys

FIGURE 4
Prevalence of T2D according to type of diagnosis and BMI. ENSANut 2006.
279x215mm (200 x 200 DPI)

Only